Density-dependent home range size in kelp greenling

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Introduction

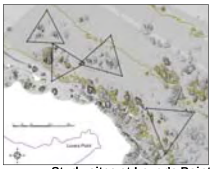
Male kelp greenling

Knowledge of how movement rates and patterns are influenced by local population density is critical to understanding how movement contributes to the density-dependent regulation of local and regional populations.

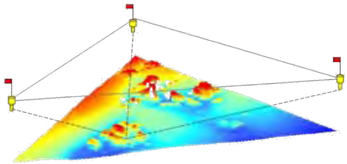
Changes in movement range in response to population density will affect ecologically important population dynamics such as immigration and emigration rates, spatial population structure, dispersion and effective population size as well as the dynamics of metapopulations.

Movement of individuals is an important parameter for spatially explicit management approaches such as marine protected areas (MPA). Population densities are expected to increase within MPAs. Therefore, understanding how movement of target species changes in responds to changing density is critical to the size design and placement of boundaries of MPAs.

In this study, I tested for change in the movement range of kelp greenling (*Hexagrammos decagrammus*) in response to experimental manipulations of population density on large patch reefs.



Study sites at Lover's Point



Acoustic VRAP array at study site. Three hydrophone buoys triangulate the position of an acoustic tag.

Methods

Study site

I conducted this study at Lover's Point of the Monterey peninsula. Four sites with a total of 8 experimental and 8 control patch reefs where established in 10 -15 meter water depth.

Acoustic telemetry

I implanted acoustic tags into body cavities of kelp greenling. High resolution acoustic triangulation (VRAP) was used to track individual fish on experimental and control reefs. Fish were tracked for a total of 20 month.

Catching kelp greenling using under water fishing techniques

Manipulation

After one year of tracking, male kelp greenling densities were reduced to 63% of initial density on the 8 experimental reefs.

Data analysis

Home ranges before and after the manipulation were estimated from acoustic telemetry data using kernel density estimates (KDE) in ArcGIS. Home range sizes on control and experimental reefs, before and after the manipulation were compared using a general linear model and I testing for an interaction effect between the manipulation and treatment.

Results

Home range size on the experimental reefs after the density manipulation was 55% smaller then on the control reefs (figure 1).

The general linear model (GLM) showed a significant interaction effect among the treatment (control vs. manipulation) and the density manipulation (table 1).

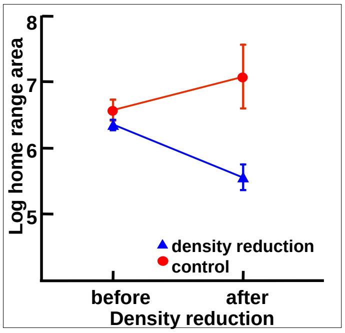
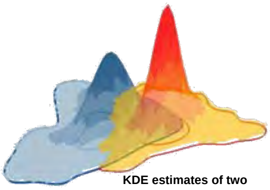


Figure 1. Home range size of male kelp greenling on the experimental and control reefs before and after the density reduction on the.



KDE estimates of two kelp greenling home ranges

Female kelp greenling

Source	Type III SS	df	Mean Squares	F-ratio	p-value
Density manipulation	0.118	1	0.118	0.654	0.428
Treatment (control vs. treatment)	4.300	1	4.300	23.90	0.000
Interaction: manipulation*treatment	2.421	1	2.421	13.463	0.001
Error	3.777	21	0.180		

Table 1. Result of GLM on log transformed data

Conclusions

This is the first study that experimentally investigated how movement changes in response to different population densities in a temperate reef fish. The positive relationship between home range size and population density in this species is likely due to co-variation in resource abundance with density. The change in home range size with density has important ecological and management implications.

Ecologically, the decrease in movement range at low densities will reduce the spatial scales over which individuals interact with conspecifics and the community. Effects of individuals on the community will be more localized and species interactions become more variable across the landscape when individuals are constrained in their movement.

Management approaches such as MPAs have to consider the effect of population density on the movement of species targeted for protection. MPA are expected to increase population densities above the current (exploited) level. Therefore, increases in movement range at higher densities has to be considered when designing MPA based on movement estimates derived from exploited populations.

Acknowledgements

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